RESULTS OF BICEPS BRACHII NEUROTIZATION USING ULNAR MEDIAN AND INTERCOASTAL NERVES

Dissertation submitted to partial fulfillment of the requirements for the degree of

M.Ch. (Plastic & Reconstructive Surgery) – Branch III

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI

AUGUST 2014

CERTIFICATE

This is to certify that **Dr. R.RAM MOHAN**, *post graduate (2011-2014) in the Department of Plastic, Reconstructive & Faciomaxillary Surgery, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai-03*, has done dissertation titles, "**RESULTS OF BICEPS BRACHII NEUROTIZATION USING ULNAR MEDIAN AND INTERCOASTAL NERVES**", under my guidance and supervision in partial fulfillment of the regulations laid down by **THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY, GUINDY, CHENNAI-32** for the degree of **MASTER OF CHIRURGIAE**, Plastic & Reconstructive Surgery (branch III) degree examination.

Signature of Dean

Dr. R. VIMALA, M.D.,
The Dean,
Madras Medical College & RGGGH,
Chennai – 600003

Signature of Guide

PROF. R. GOPINATH, M.Ch.,
Professor and Head of Department of
Plastic & Ronstructive Surgery,
Madras Medical College & RGGGH,
Chennai – 600003

CERTIFICATE

This is to certify that the dissertation entitled "**RESULTS OF BICEPS BRACHII NEUROTIZATION USING ULNAR MEDIAN AND INTERCOASTAL NERVES**" is a bonafide work done **DR.R.RAM MOHAN**, *post graduate (2011-2014) in the Department of Plastic, Reconstructive & Faciomaxillary Surgery, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai – 03,* in partial fulfillment of the University rules and regulations for award of **Master of Chirurgiae**, ***Plastic & Reconstructive Surgery (Branch-III)*** degree under my guidance and supervision during the academic year 2011-2014.

Signature of Dean

Dr. R.VIMALA, M.D.,
The Dean,
Madras Medical College & RGGGH,
Chennai – 600003

Signature of Guide

PROF.R.GOPINATH, M.Ch.,
Professor and Head of Department of
Plastic & Ronstructive Surgery,
Madras Medical College & RGGGH,
Chennai – 600003

DECLARATION

I solemnly declare that this dissertation "**RESULTS OF BICEPS BRACHII NEUROTIZATION USING ULNAR MEDIAN AND INTERCOASTAL NERVES**" was done by me in the Department of Plastic, Reconstructive & Faciomaxillary Surgery, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai-03 between 2011 and 2013.

This dissertation is submitted to **THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY, GUINDY, CHENNAI-32** in partial fulfilment of the university requirements for the award of degree of **M.Ch. PLASTIC & RECONTRUCTIVE SURGERY**.

Place: Chennai　　　　　　　　　　Signature of the Candidate

Date:

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CONTENTS

INTRODUCTION:

Imagine waking up to realize that your hand simply stops following your command. In a nut shell this is what happens in brachial plexus injuries.

Absence of functionality is one of the devastating effects of brachial plexus injuries. Apart from it brachial plexus injury also results in loss of sensation in the affected limb. The affected person also undergoes a period of depression. Many affected persons never return to their normal life.

Brachial plexus injury has plagued human species for a long time. It was only at the beginning of this century people started treating brachial plexus injuries. Only in the preceding thirty to forty years advances were made in treatment of brachial plexus injuries.

Treatment of brachial plexus injury is multi-staged. Separate operations are required for shoulder, elbow and finger reanimation. Physiotherapy plays an integral role in treatment of brachial plexus injuries. Regular physical rehabilitation before and after surgery is necessary. Patients should be informed about the expected outcome and the need for regular physiotherapy.

This clinical study deals with one aspect of brachial plexus injury namely the elbow reanimation. The nerve transfer procedures for elbow re-animation are compared in this study in terms of number of days for achieving elbow flexion against gravity, post-operative pain and number of days at hospital. In this study biceps brachii is neurotized. Though the recovery is not complete ,that is –the patient will never revert back to his previous state, it gives useful functional ability to carry out daily activities. As they saying goes “ For a man with nothing giving something is a big deal”.

A motivated patient with skilled surgeon and physiotherapist are the keys to the success of this multi-step process of elbow re-animation.

AIM AND OBJECTIVES:

1. To analyze the elbow restoration techniques in brachial plexus injuries
2. To compare functional outcomes of the procedures.
3. To compare patients perspective of the procedures.
4. To assess the complication rates of the procedures

REVIEW OF LITERATURE:

In 1913, Tuttle described the first ever attempt at neurotization for the restoration of functions in brachial plexus injuries. Narakas thirty years ago described the principles and rationales of nerve transfers in brachial plexus injuries[12, 13, 14]. Since then the use of nerve transfers in treatment of brachial plexus injuries have increased exponentially.

Nerve transfers have opened up new avenues in treatment of brachial plexus injuries. Muscles which became useless due to brachial plexus injury were rendered functional by nerve transfers. Nerve transfers were a major advance in treatment of brachial plexus injuries. The principle is that an undamaged nerve innervating a muscle can be reanimated with neurosynthesis using a donor nerve sub serving another function.

Dr Christophe Oberlin , in 1994, described the first ever nerve transfer for elbow re-animation[23]. He described the transfer of ulnar nerve fibres to the musculocutaneous nerve branch supplying the biceps brachii. He put forth the theory that the ulnar nerve fibres can be safely isolated in the arm using nerve stimulator and can be transferred to the biceps brachii branch of the musculocutaneous nerve so as to innervate the muscle.

At first people were skeptical about the procedure. They doubted whether motor fascicles supplying the hypothenar muscles can be separated at the mid arm level and that there will be no loss of ulnar nerve functions. Oberlin proved without doubt that nerve fascicles of ulnar nerve can be separated at the mid arm level and the resulting functional loss of the donor nerve is very limited.

Sir Herbert Seddon first described the use of intercostal nerve transfers for elbow reanimation[20,21,22]. He explained that inter coastal nerves which are both sensory and motor can be used for nerve transfers to reanimate elbow. His methods were not widely accepted. Recently there was a revival in this technique. Now a days intercostal nerve transfers are a standard in global brachial plexus injury.

A lot of novel methods of nerve transfers have come up lately. It is upto the operating surgeon and the clinical situation to dictate the type of nerve transfer to be carried out.

Mckinnon described the double transfer technique where motor fascicles of the ulnar and median nerves are transferred to biceps brachii and brachialis respectively.

Median pectoral nerve transfer to musculocutaneous branch of biceps brachii was demonstrated by mackinnonn and brandt. Phrenic nerve can also be used for elbow reanimation. The nerve is harvested endoscopically and transferred to the musculocutaneous nerve. The downside of this method is that harvesting of the nerve in the left side is more difficult. Moreover this technique could not be followed in children and definitely not on children who are below the age of three.

In the early 1990s Dr Gu advocated the use of contralateral C7 cross neck nerve transfers[36,37,38]. This method is not widely practiced as it involves harvesting a nerve from normal unaffected side. Later studies also revealed that the functional outcome of this procedure was very little.

Lately Dr Julia Terzis proposed additional transfer of lateral cutaneous nerve of forearm to musculocutaneous nerve in addition to the intercostal nerve transfer[7,23]. The idea is to make use of misdirected motor fibres of the transferred intercostal nerves.

Pectoralis major and lattismus dorsi muscles were also used for elbow reanimation[18,25]. With the advent of microsurgical techniques free functional muscle transfers were also done for elbow reanimation, especially gracilis transfer.

FUNCTIONAL ANATOMY

Brachial plexus is a myriad of nerve connections extending from the neck region to the axilla. The anterior primary rami of the cervical spinal nerves (C5 to C8) and first thoracic spinal nerve (T1) form the brachial plexus.

If the spinal nerve C4 contributes more to the brachial plexus than T1 then it is termed as a “pre fixed brachial plexus”. If the spinal nerve T2 contributes more to the brachial plexus then it is termed as a “post fixed brachial plexus”.

In the clinical set up pre fixed brachial plexus is more common than the post fixed brachial plexus. In fact a post fixed brachial plexus injury is rare.

Each of the spinal nerve is formed by the fusion of dorsal and ventral rami a few millimeters after exiting from the ganglion. Each root is formed by a number of rootlets.

The ventral roots carry the motor fibres to the distal muscles. The dorsal roots carry sensory fibres from the periphery to the central nervous system.

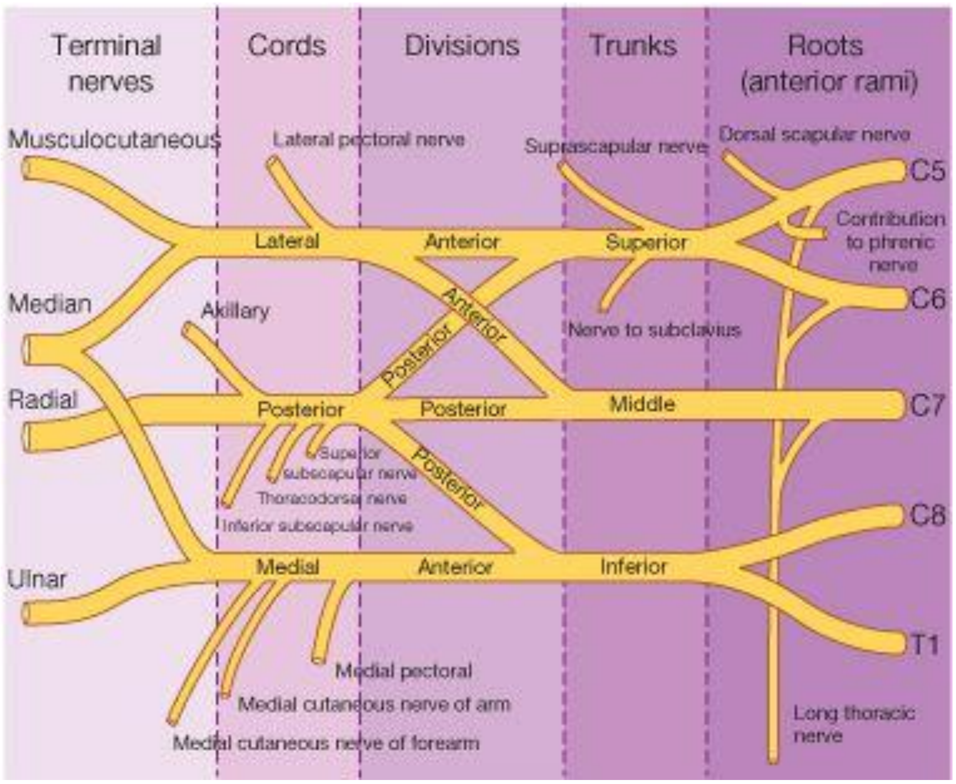


Fig.1: schematic diagram of brachial plexus

After exiting through the inter scalene space between scalenus anterior and scalenus medius the post ganglionic spinal nerves unite to form three trunks. The upper trunk is formed by the union of spinal nerves C5 and C6. The middle trunk is continuation of the C7. The lower trunk is formed by the union of the spinal nerves C8 and T1.

Just as the trunks reach the clavicle they divide into anterior and posterior divisions. The divisions pass underneath the clavicle. The divisions further unite to form the cords. All the posterior divisions unite to form the posterior cord. The anterior divisions of the middle and anterior trunk unite to form the lateral cord. The medial cord is continuation of anterior division of the inferior trunk.

The cords give out two or more peripheral nerves. At all levels numerous branches arise from the brachial plexus.

The posterior cord of the brachial plexus continues as the radial nerve. The lateral cord divides and gives rise to the lateral root of the median nerve and continues as the musculocutaneous nerve. The posterior cord gives rise to axillary artery and continues as the radial nerve. The median cord gives the medial root of the medial nerve and continues as ulnar nerve.

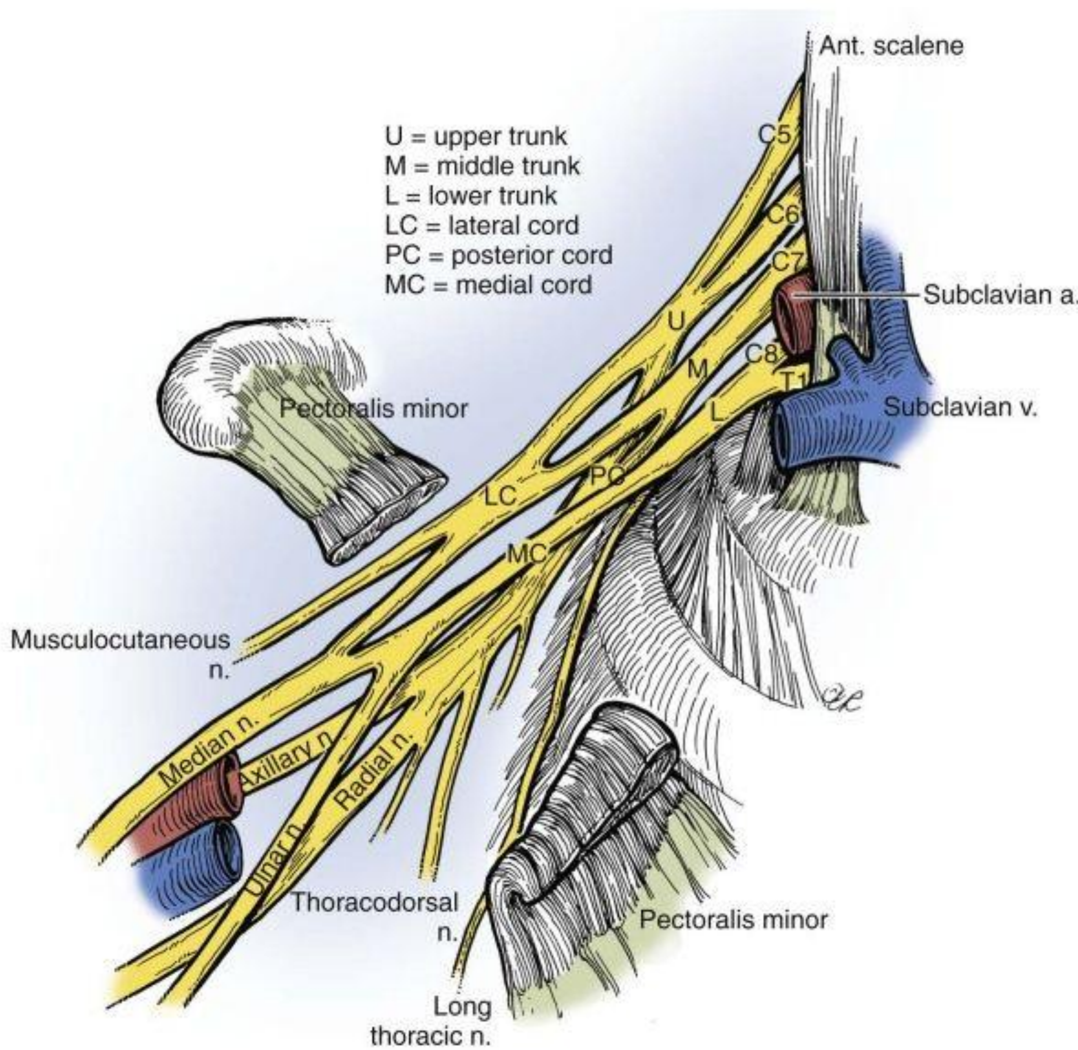


Fig 2: Different branches and their orientation

Branches at various levels:

A handful of nerves arise from the brachial plexus at various levels.

Root :

Dorsal scapular nerve

Long thoracic nerve

Upper trunk:

Nerve to subclavius

Suprasccapular nerve

Lateral cord:

Lateral pectoral nerve

Musculocutaneous

Lateral root of median

Medial cord:

Median pectoral nerve

Median cutaneous nerve of the arm

Median cutaneous nerve of the forearm

Ulnar nerve

Median root of median nerve

Posterior cord:

Upper subscapular nerve

Lower subscapular nerve

Thoracodorsal nerve

Axillary nerve

Radial nerve

The brachial plexus injuries can be divided into supraclavicular lesions including the injuries to roots, trunk and divisions. The infraclavicular lesions include injuries to the cords and terminal branches. Global palsies include lesions involving all the spinal nerve roots. Partial palsies are injuries where only a certain nerve roots are involved.

Brachial plexus injuries can be further divided into different levels depending on the level of the injury.

Level 1:

Injury located within the vertebral column. This level includes injuries to spinal cord, rootlets and roots.

Level 2:

The place of injury is the inter scalene space. This is post ganglionic injury located proximal to the suprascapular nerve.

Level 3:

This level includes injuries at the retro clavicular and supraclavicular level. This level involves injuries to the trunks and divisions.

Level 4:

Infra clavicular injuries involving the cords and peripheral nerves are included in this level.

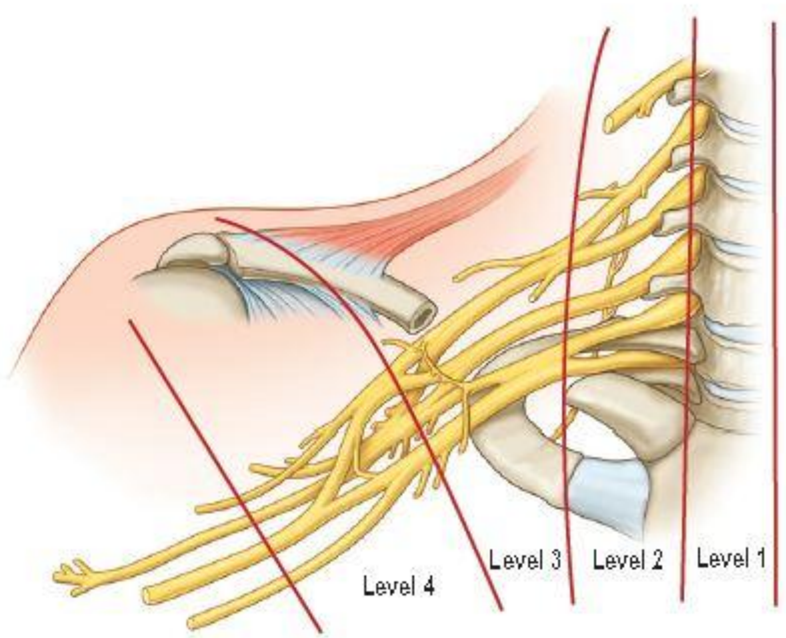


Fig 3: Levels of injury

SURGICAL OPTIONS:

For global palsies the choices we have are intercostal nerve transfers , contralateral C7 transfers, phrenic nerve transfers and medial pectoral nerve transfers. All these are extra plexial transfers. Phrenic nerve harvesting is very difficult requiring the use of microscope. Post operatively the patient may have difficulty in breathing. Harvesting the nerve in the left side is more difficult. Moreover this procedure is contra indicated in children.

C7 transfers from the opposite side involves dividing the nerve from the uninvolved side. The results from the procedure are not much encouraging.

Intercostal nerve transfers are much safer. The donor nerve morbidity is almost nil. This etra plexial transfer is the preferred method in our study.

For partial palsies where the roots C8 and T1 are intact intra plexial transfers are done. Both the median and ulnar nerves can be used as the donor nerves. The disadvantage of distal nerve transfer is that the risk of iatrogenic injury is higher. A functionally important nerve is utilized for the transfer. The advantages is that the dissection is far away from the site of injury. Also operating in the virgin area means easier dissection, shorter operating time. The site of co-aptation is also very close to the target muscle. In partial plexus injury the preferred method is intra plexial transfers.

Double nerve transfers in a single setting is also done. Recently encouraging results are reported in double nerve transfers. In our study we have compared the outcomes of nerve transfers using ulnar and median nerves.

SURGICAL TECHNIQUE:

INTERCOSTAL TO MUSCULOCUTANEOUS NERVE TRANSFER:

Just distal to the coracoid process the musculocutaneouos nerve originates from the lateral cord. It then pierces the corachobrachialis muscle. Then it runs on the deeper surface of the biceps muscle. The musculocutaneous nerve then gives one or more branches to the biceps muscle. These branches enter the muscle at approximately 12cm distal from the acromian process of the scapula. Two types of innervation of the biceps muscle are found.

Type 1:

A common trunk is given out from the musculocutaneous nerve which later divides into two branches supply the short head and long head of the biceps.

Type 2:

Two separate branches are given out from the musculocutaneous nerve. Each branch separately supplies the short head and long head of the biceps. The branch to the short head of the biceps muscle usually originates a little proximal on the musculocutaneous nerve. Very frequently intercommunicating branches between the branches to the short head and long head are seen.

After travelling a short distance of 1 or 2cms these branches divide into the terminal branches. These terminal branches are distributed throughout the muscle belly.

Then the musculocutaneous nerve gives rise to one or more motor branches to the brachialis muscle at about 17cm distal to the acromion process of the scapula. The musculocutaneous nerve then continues as the lateral cutaneous nerve of the arm.

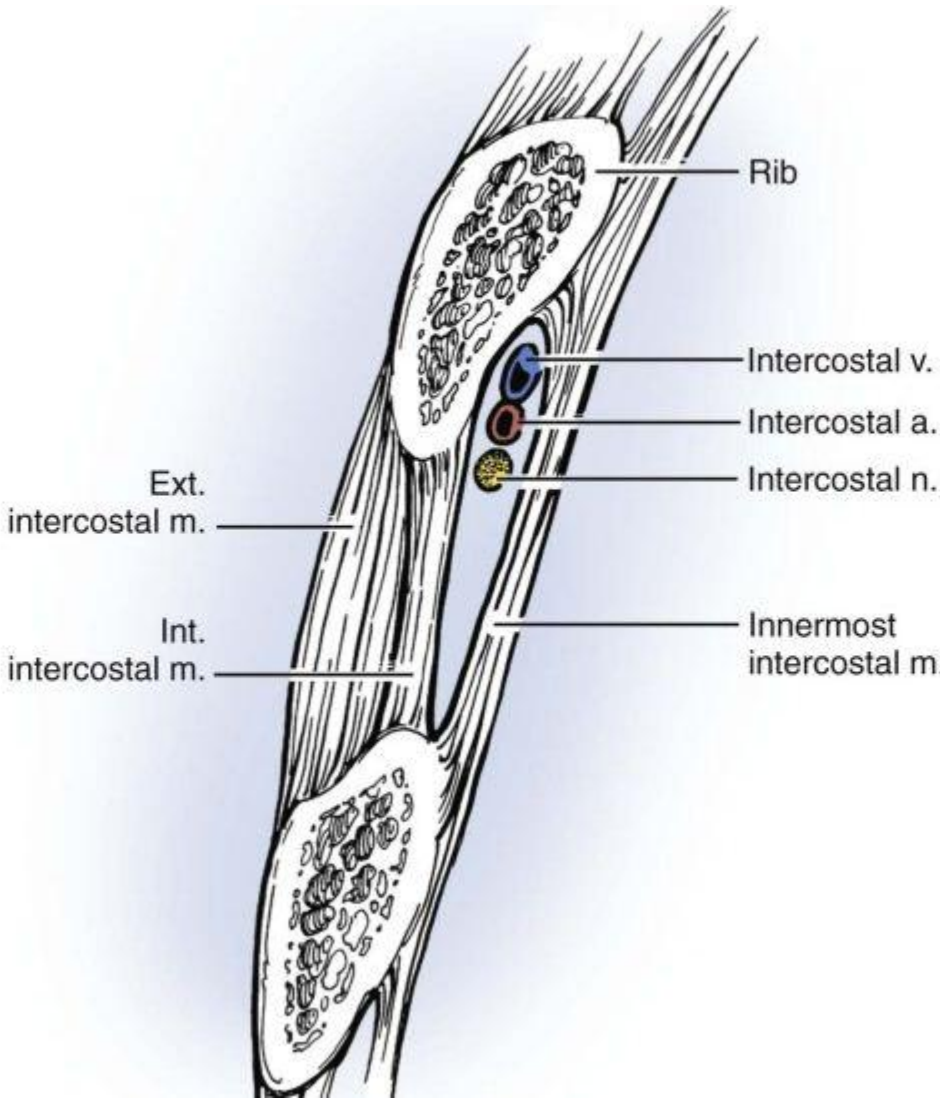


Fig 4: Anatomy of Intercostal nerve

The intercostal nerve runs along the inferior aspect of the ribs on the pleural side of the intercostal muscles. At the posterior wall of the axilla the intercostal nerve enters deep to the intercostal muscles. The intercostal nerve travels between the intercostal muscles. The external intercostal muscle and the internal intercostal muscles lie anterior to the nerve. The innermost intercostal nerve is posterior to the nerve. The lateral cutaneous branch pierces the intercostal muscles and proceeds towards the skin and then divides into the dorsal and ventral branches.

The anterior cutaneous branch traverses through the pectoralis major muscle to reach the skin. This branch pierces the muscle close to the sternum.

The intercostal nerve is accompanied by the intercostal artery and vein. From the cephalic to the caudal direction the arrangement is intercostal vein followed by intercostal artery and then the intercostal nerve.

The patient is positioned in a supine position with the involved limb at 90^o abduction and externally rotated. Under general anaesthesia the whole of upper limb and the pectoral region are painted and draped. A wavy incision is made. The incision extends from the medial side of the arm. It traverses across the axillary region to the pectoral region. In the pectoral region the extension of incision is made along the 4^{th} intercostal space.

The sub cutaneous tissue ,pectoralis major and pectoralis minor muscle are elevated. The pectoral muscles are separated from their insertions distally so that both the muscles are not injured. The anterior surface of the ribs whose corresponding nerves are to be dissected are dissected. The serratus anterior muscle is preserved. The long thoracic nerve which courses along the posterior border of the mid axillary line is identified and preserved. The periosteum is incised and elevated circumferentially using a periosteal elevator. The rib is retracted using a umbilical tape. The intercostal musculature is exposed.

The intercostal nerve is identified and dissected taking care not to injure the underlying pleura. Earlier surgeons used to resect the ribs partially or perform osteotomy. Now it is not done regularly. The periosteal sleeve is incised along the mid clavicular line. The sensory branch is identified laterally. It is found between the mid axillary and anterior axillary lines. This branch is usually larger than the motor branch. It can be traced back to locate the motor branch. The motor branch can also be confirmed using a electrical stimulator.

Dissection of the nerve is done posteriorly upto the mid axillary or the posterior axillary line. Anteriorly the dissection can be extended upto the costo-chondral junction. After the dissection the nerve is passed below the serratus anterior muscle to reach the axillary region. Pleural leak or pleural tear should be noted and repaired immediately. If the tear is small it should be closed primarily using a purse string suture. If the tear is large an intercostal drainage tube is inserted and managed accordingly. The process was repeated for the other intercostal nerves. Two to three nerves are coapted to the musculocutaneous branch supplying the biceps muscle.

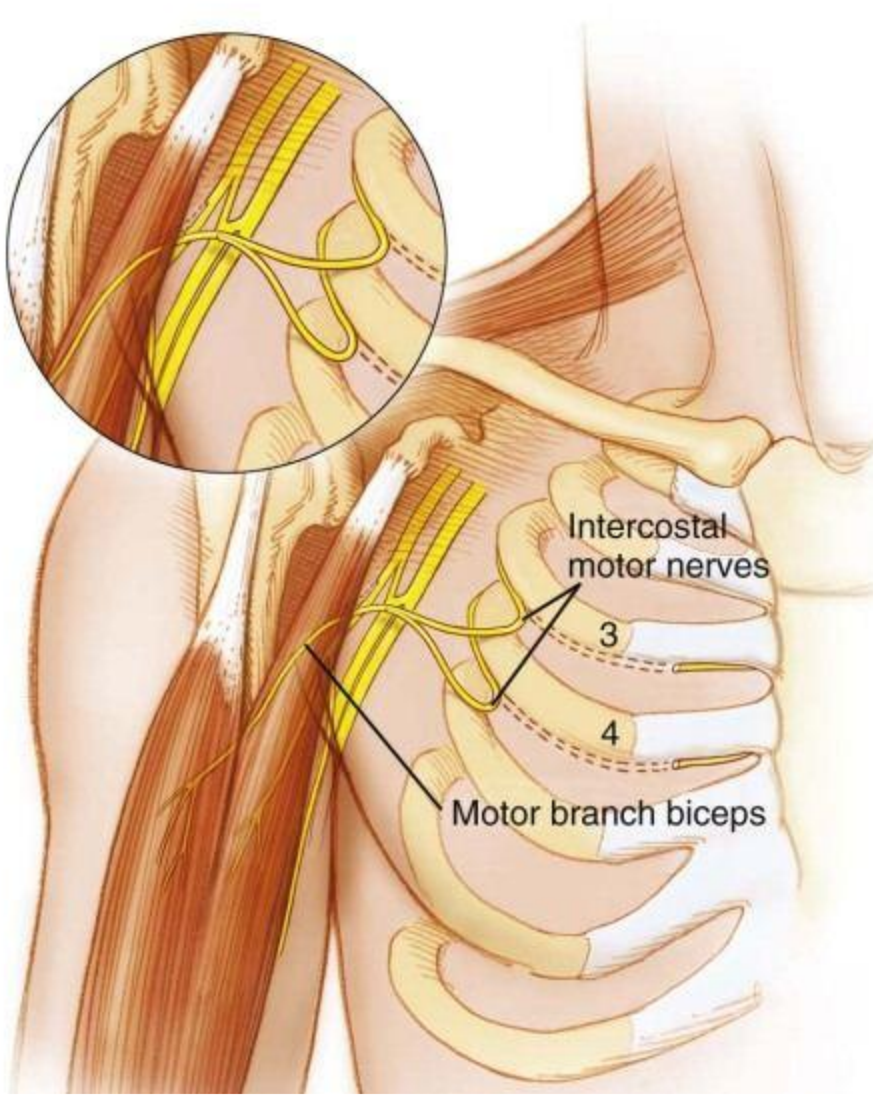


Fig 5: Intercostal nerve transfer

The incision over the medial aspect of the arm is deepened. The musculocutaneous nerve is identified and dissected. The branch supplying the biceps brachii muscle is identified and dissected. After adequate dissection is done, the intercostal nerves are flipped back and coapted with the branch from the musculocutaneous nerve supplying the biceps brachii muscle. The nerve coaptation is done using microscope with a 9-0 nylon.

It has to be made sure that the site of coaptation is not under tension. Direct coaptation is done without using nerve grafts.

Post operatively shoulder immobilization is done for 3 weeks.

Ulnar nerve to musculocutaneous nerve transfer:

This procedure was first described by Christophe Oberlin. It is widely known as Oberlin I.

The patient is placed in supine position with the affected limb at 90^0 abduction and external rotation. The whole of the upper limb is painted and draped so that the electrical stimulator can be used intra-operatively. Here a short longitudinal incision over the medial aspect of the upper arm is made. The musculocutaneous nerve is dissected and its branches are identified. Then the ulnar nerve is identified and intra perineurial dissection is done. Using a electrical stimulator the fascicles supplying the flexor carpii ulnaris muscle are identified. Topographically these motor fibres are located on the postero-medial region. One or two fascicles are resected depending upon the thickness of the musculocutaneous nerve. Under magnification the interfascicular connections are identified. Proximal to these interconnections the fascicles are dissected.

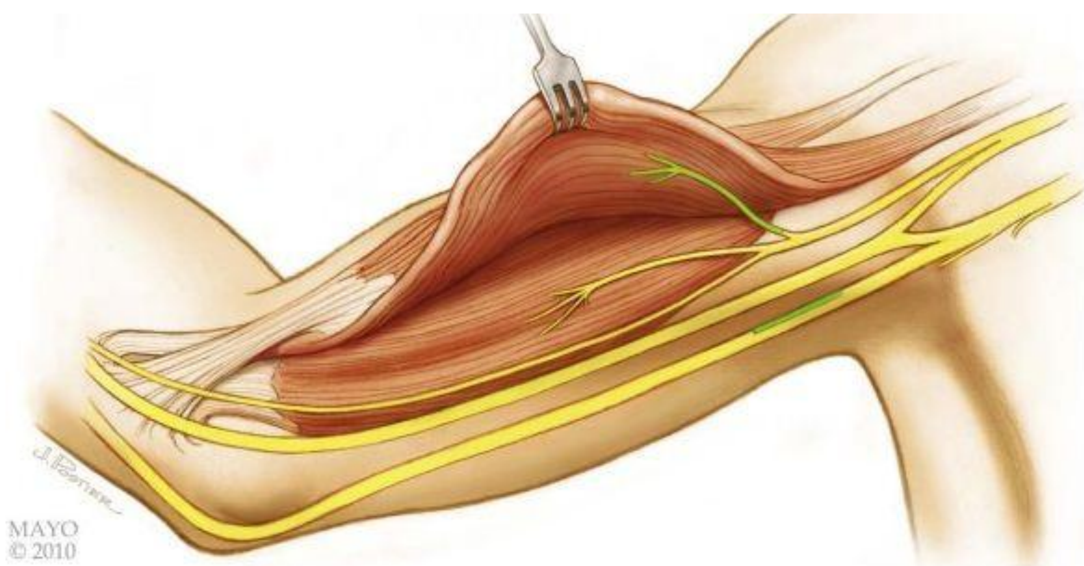


Fig 6: Topography of Ulnar and Musculocutaneous nerve

The branch to the biceps brachii from the musculocutaneous nerve is dissected at adequate distance so that the coaptation can be made without tension. Then coaptation is done using 9-0 nylon epineural sutures.

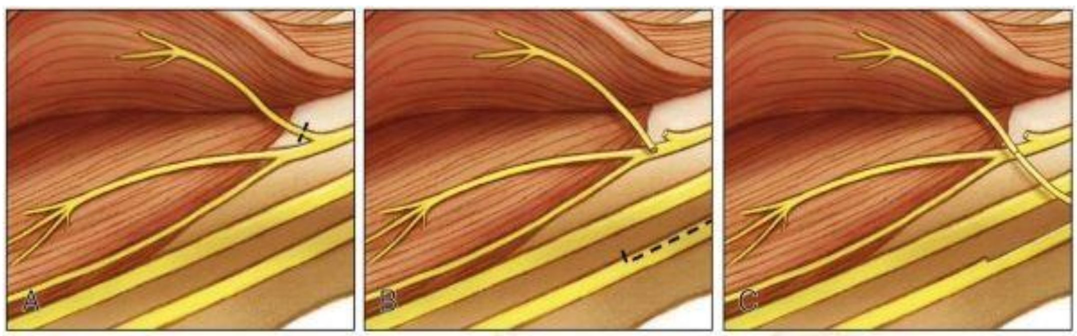


Fig 7: operative steps for Oberlin 1.

Post operatively the limb is immobilized for 3 weeks.

Median nerve to musculocutaneous nerve transfer:

The patient is placed in supine position with the arm abducted at 90^0 and externally rotated. An incision similar to the ulnar nerve transfer on the medial aspect of the forearm is made. The musculocutaneous nerve is identified along with the branches to the biceps branchii and brachialis are identified. The median nerve which is the largest nerve at this proximal part of the arm is identified. Under magnification the perineurial dissection is done. Several fascicles are isolated.

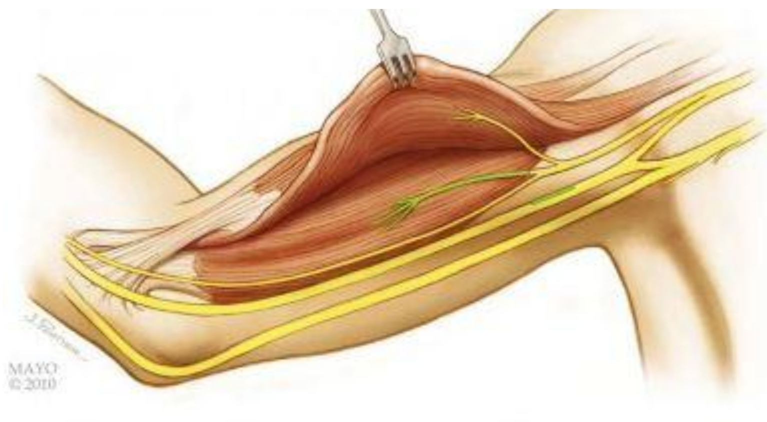


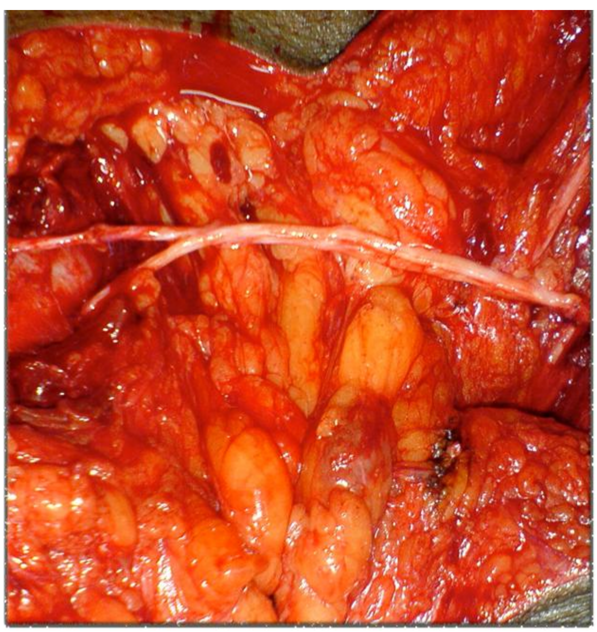
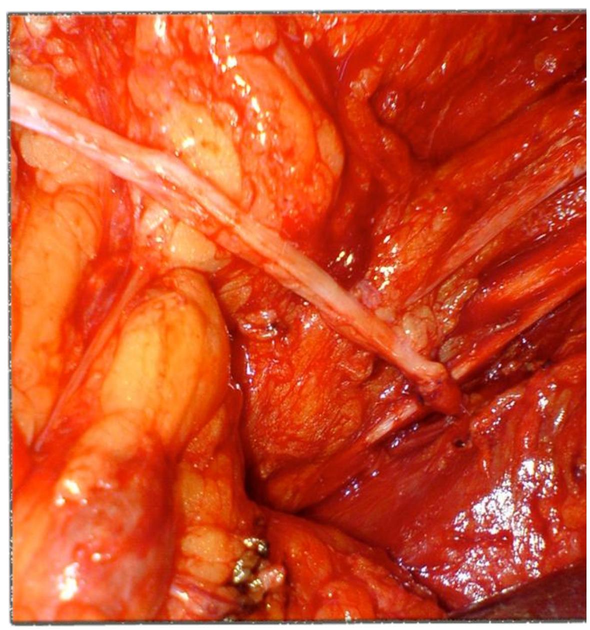
Fig 8: The median nerve to be coapted highlighted in green.

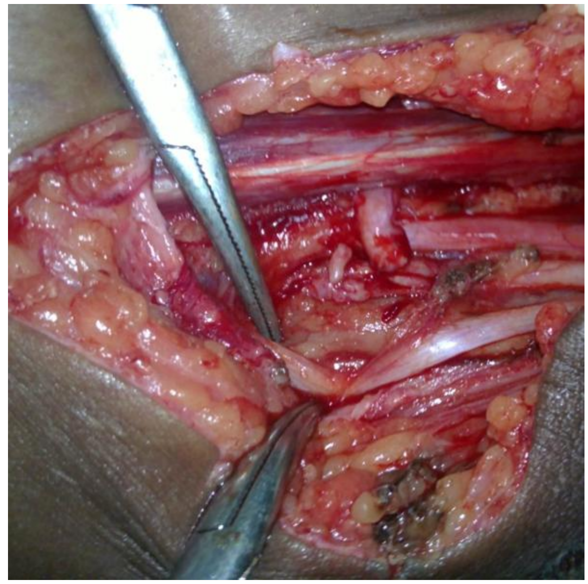
Electrical stimulator is used to locate the fascicles innervating the flexor carpi radialis are isolated. The fascicles are dissected proximal to the interfascicular connections. The musculocutaneous nerve is dissected and coapted with the fascicles of the median nerve using 9-0 nylon sutures.

Fig 9: operative steps for median nerve transfer

Post operatively 3 weeks immobilization is done. Physiotherapy is started after 3 weeks.





MATERIALS AND METHODS:

A clinical study was conducted in the department of Plastic Reconstructive and Maxillofacial Surgery, Madras Medical College and Rajiv Gandhi Government Hospital over a period of 28 months from October 2011 to January 2013.

STUDY POPULATION:

The study populations in the present study were the people who visited the hospital for brachial plexus injury treatment.

INCLUSION CRITERIA:

- Patients with brachial plexus injury where
- Direct neurotization is done.
- Post-operatively Grade 3 – Elbow Flexion is present
- Age between 19 – 45

EXCLUSION CRITERIA:

- Patients with nerve grafts
- Patients with muscle power less than Grade 3

ETHICAL CLEARANCE:

The ethical clearance was given by the Institutional ethics Committee of Madras Medical College.

INFORMED WRITTEN CONSENT:

Informed and written consent was obtained from all the patients prior to the start of the study.

SAMPLE SIZE:

A sample size of 43 patients underwent treatment for brachial plexus injury in this study.

COLLECTION OF DATA:

The data was collected with a proforma regarding patient’s injuries and treatment parameters. The time of injury, mode of injury, the type of surgery done, the distance from coapted site to the neuromuscular junction, the number of days patient remained in hospital post operatively, the severity of the pain experienced by the patient, the number of days required to achieve grade III muscle power are noted.

PROCEDURE:

Detailed history was recorded.

Patients are clinically examined

Based on etiology, surgery was planned either emergency or elective.

Patients were taken up for surgery under GA.

Based on the roots involved the type of surgery is decided.

FOLLOW UP PROCEDURE:

The patients are followed up at weekly intervals for a period of one month. Then they are followed once a month for 6 months.

Assessment of outcome:

Post-operative complications were assessed.

Wound infection

Seroma

Haematoma

Donor nerve sensory deficit

The time taken to achieve Muscle power Grade III

STATISTICAL ANALYSIS:

The data collected were analyzed at the end of the study.

OBSERVATION AND RESULTS:

A total of 43 patients were included in this study over a period of 28 months between October 2011 and January 2014. Patient related, injury related and treatment related parameters were collected. Age in years, gender and co-morbid illness were noted as patient parameters. The time , etiology are noted as injury related parameters. The type of surgery, complications and number of days required to achieve Grade III are noted as treatment related parameters.

Case distribution:

As the number of cases of global palsies are higher in our study, the number of intercostal nerve transfers are more. The distribution of cases is given below:

Table 1: Distribution of cases

S.No	PROCEDURE	NUMBER OF CASES
1	Intercostal nerve transfer	24
2	Ulnar nerve transfer	13
3	Median nerve transfer	6

Chart 1: Distribution of cases

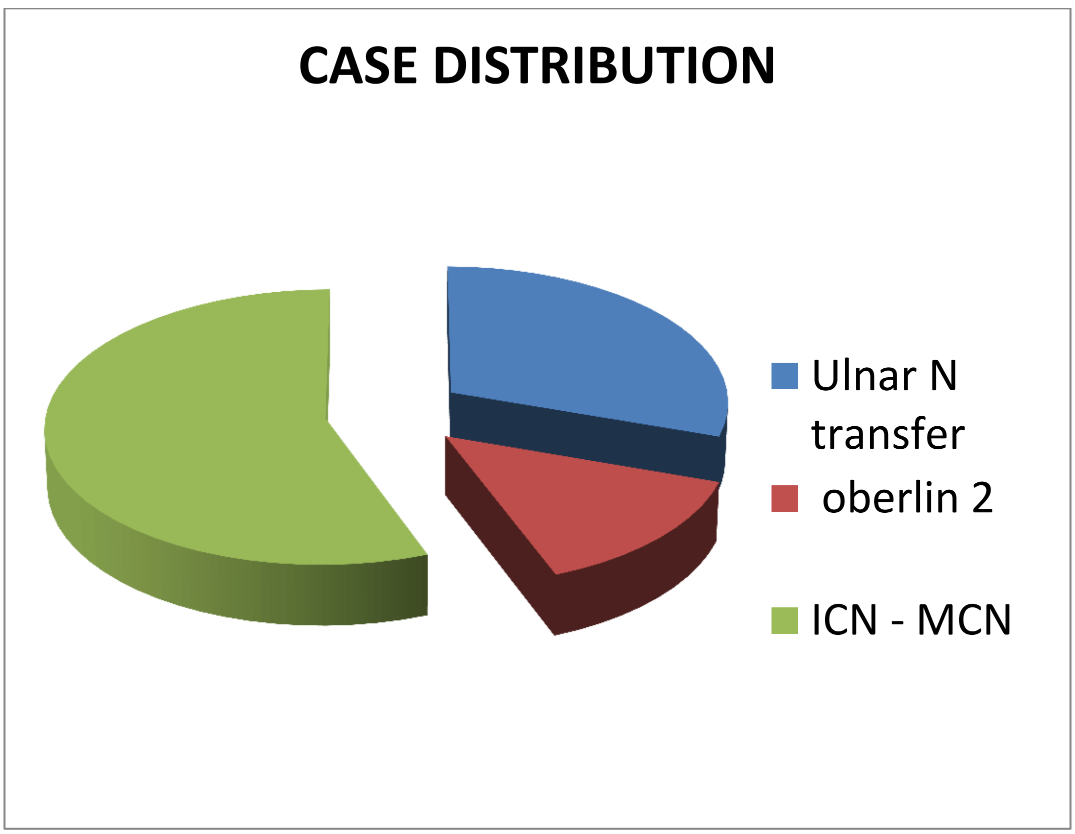


Table 2: Age distribution

s.no	Age in range	Number of patients
1	25-35	21
2	35-45	13
3	45-55	9

Chart 2: Age distribution

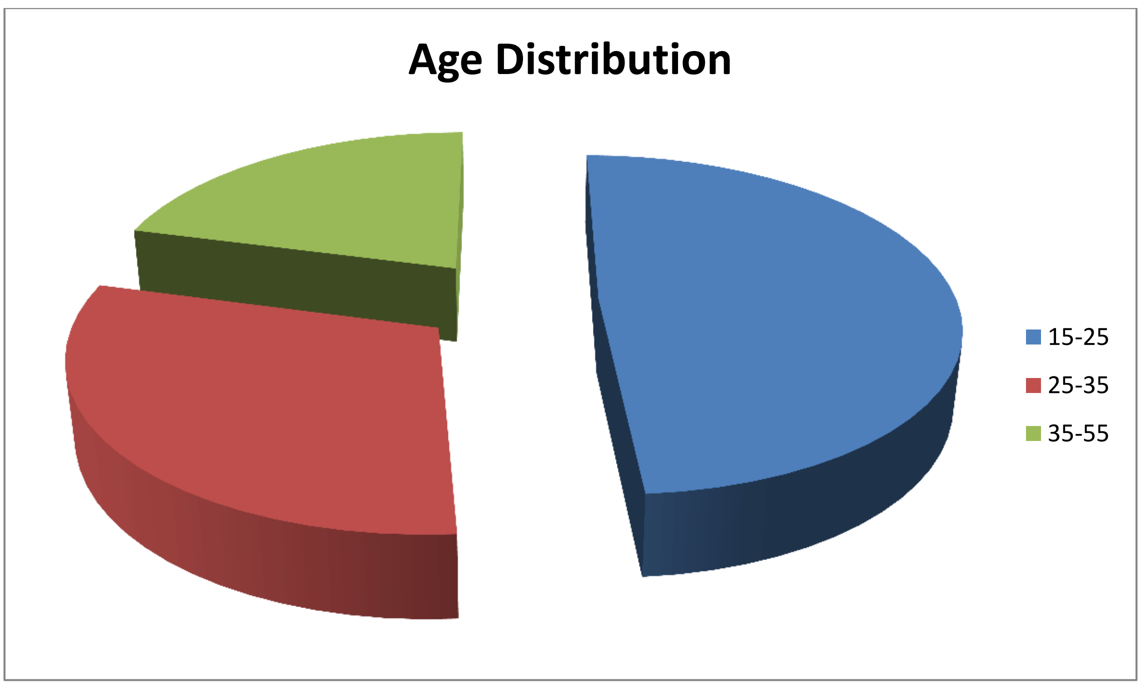
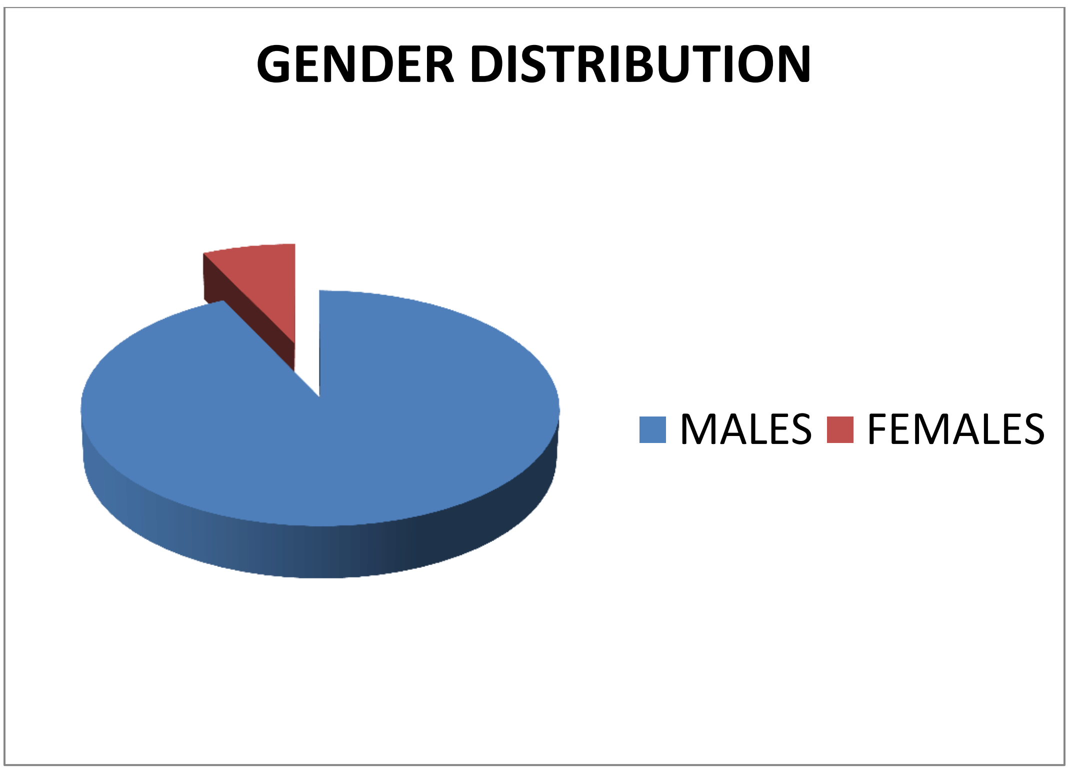


Table 3: Gender distribution

s.no	Gender	Number of patients
1	male	39
2	female	4

Chart 3: Gender distribution



Etiological factors:

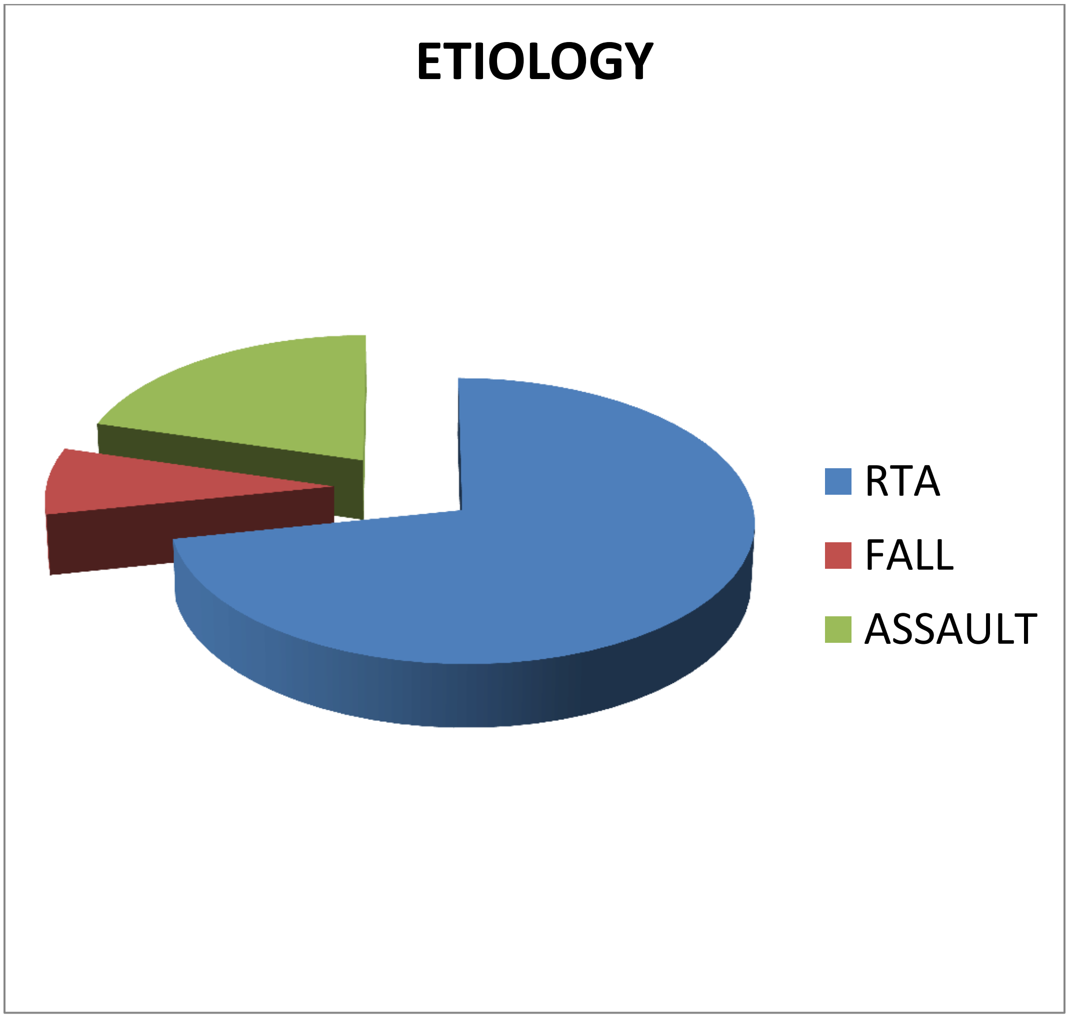
Road traffic accidents are the major cause of brachial plexus injuries followed an almost equal distribution of fall from height (industrial and unrelated) and assault.

This also explains the skewed sex ratio in our study.

Table 4: Etiological factors

S.No	Etiological fractures	Number of patients
1	RTA	28
2	Fall from height	7
3	Assault	8

Chart 3: Etiological factors



Complications:

There was no difficulty in respiratory movements in all intercostal nerve transfers. One patient had accidental puncture of pleura. The tear was closed primarily. Leak test was done to confirm no air leak after repair.

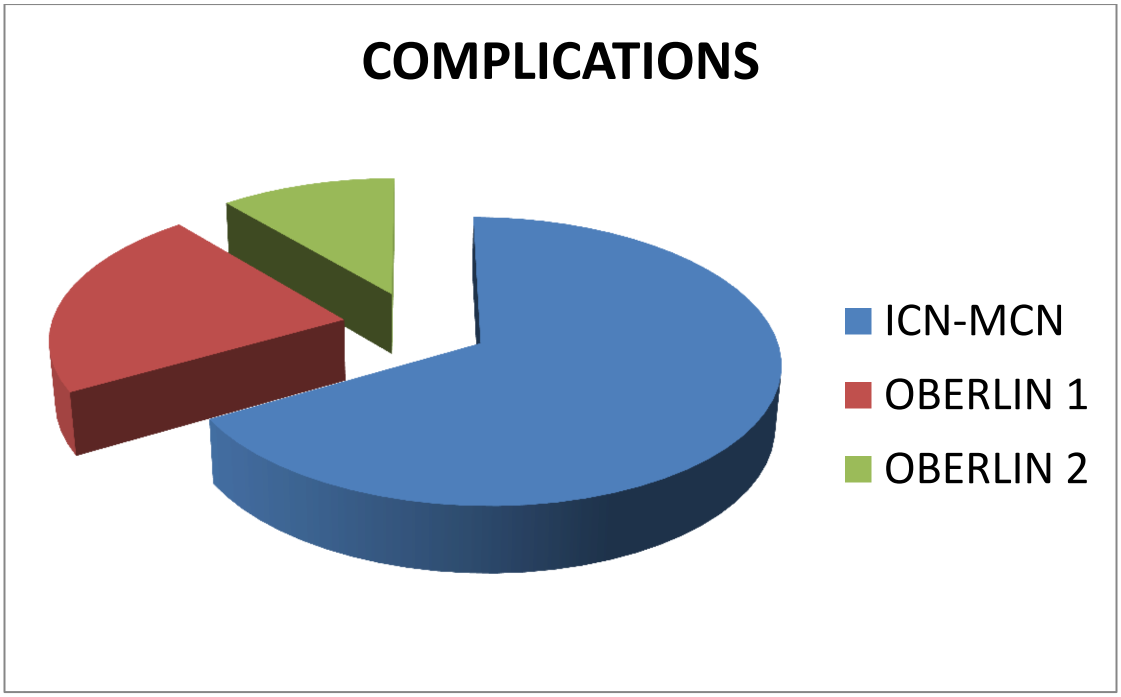
The complications related to longer incision and tissue handling are much common in intercostal nerve transfer. The complications encountered are seroma formation, hematoma formation, wound dehiscence and infection.

The patients in ulnar and median nerve transfers had only transient loss of sensations in the regions supplied by the corresponding nerves.

Table 4: Complications

S.No	PROCEDURE	NUMBER OF CASES
1	Intercostal nerve transfer	12
2	Ulnar nerve transfer	4
3	Median nerve transfer	2

Chart 4: Complications



Distance from coaptation site to NMJ:

The distance of the neuromuscular junction from the coapted site is measured. This represents the distance the nerve has to grow distally to innervate the muscle.

Table 5: Distance from coaptation site to NMJ

S.No	Procedure	Distance in cms
1	Intercostal nerve transfer	5.5
2	Ulnar nerve transfer	1.5
3	Median nerve transfer	1.7

Chart 5: Distance from coaptation site to NMJ

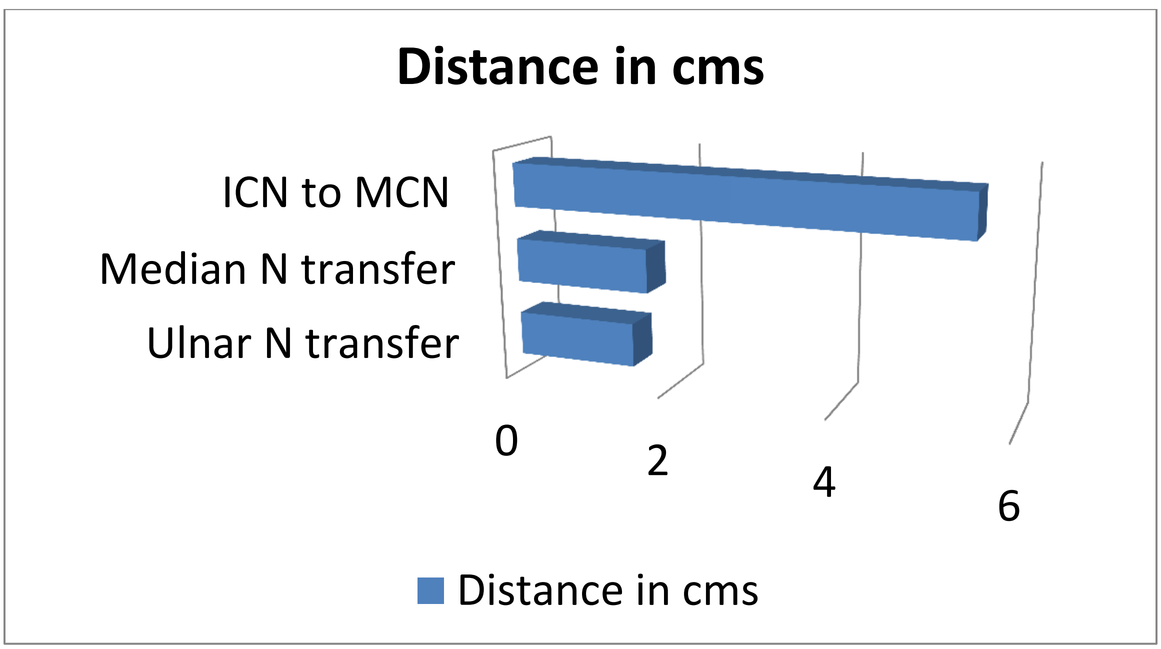
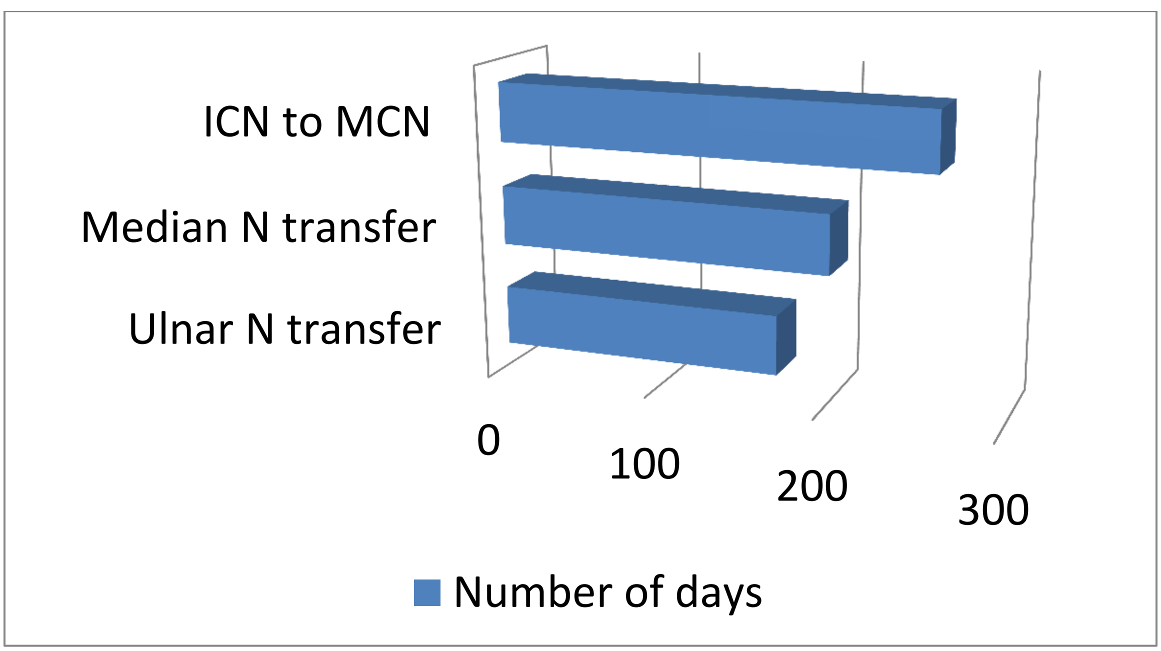


Table 6: Number of days required to get Grade III muscle power

S.No	PROCEDURE	NUMBER OF CASES
1	Intercostal nerve transfer	260.5
2	Ulnar nerve transfer	170
3	Median nerve transfer	200.5

Chart 6: Number of days required to get Grade III muscle power



Discussion:

Before formulating the treatment plan for brachial plexus injuries many factors are taken into consideration. Patients expectations and comorbid conditions should be taken into account. The results of previous operations and the outcomes of the planned procedures should be explained to the patients.

The present status of the limb with regard to motor and sensory functions should be taken into account. A sound knowledge of the brachial plexus anatomy, the various branches and their spatial orientation is of paramount importance to a successful nerve transfer. The resulting donor nerve morbidity should also be taken into account while planning the procedure and the same should be explained to the patient.

Various etiological factors are responsible for a brachial plexus injury. Thorough clinical examination to determine the level of injury and severity of the injury should be done.

The principles to be followed in nerve transfers for maximizing the outcomes are

1) The target muscle should be neurotized as near the muscle as possible.
2) Direct repair without nerve grafts. Use of nerve grafts have an adverse effect on outcome
3) To choose nerve donors with similarly behaving neuromuscular elements.

In our study it was noted that global palsies are more frequent than partial palsies. Since intra plexial transfers are not possible in these cases due to the lack of a functional donor nerve extra plexial transfers are the only options. The preferred nerve is the intercostal nerve.

The advantage of this nerve transfer is that the donor nerve morbidity is nil. The dissection of the intercostal nerve is difficult and time taking. The learning curve is steep. A very long incision is needed for the procedure. As a result of the long incision the post-operative complications pertaining to the incision like post-operative pain, seroma formation, haematoma formation, wound dehiscence are higher in this group.

The distance from the coaptation site to the neuromuscular junction is longer as the nerve is brought from another region. Also the intercostal nerve contains a fair amount of sensory fibres. The chances of mismatched sensory to motor coaptation is high.

Post-operative training to the patient is very important. The fact that initially the patient should take deep breath for elbow flexion should be explained to the patient. Later on the elbow flexion will become independent of the respiratory movement as the cerebral plasticity takes over.

In partial palsies either ulnar nerve or radial nerve is transferred. The selection of the donor nerve is determined by the clinical presentation of the patient. The strength of contraction of the muscles supplied by the nerve dictates the suitable donor nerve.

In ulnar nerve transfers the incision is much smaller. The incision is also hidden from plane sight. The dissection and tissue handling is very little compared to intercostal nerve transfer. Consequently the post-operative complications like seroma formatiom, haematoma formation, pain and wound dehiscence are less compared to intercostal transfer.

The distance from the neuromuscular junction to the coaptation site is shorter. This is due to the close proximity between the nerves at the level of the mid-arm.

The median nerve transfer also utilizes a similar incision. The merits of this procedure is similar to the transfer of the ulnar nerve. The most frequent complication among ulnar and median nerve transfers is that there is transient loss of sensation over the regions supplied by the corresponding nerves.

In our study is also found that the distance between the neuromuscular junction and coaptation site is a little bit higher for median nerve transfer. Post-operatively the patients were able to follow the physiotherapy regimens easily.

This study aims to compare the duration of recovery in all these procedures. The cut-off point was kept as elbow flexion against gravity. That is achieving a muscle power of Grade III.

With muscle power of Grade III the patient was able to carry out his daily activities. The time taken to achieve this power and the possible reasons for the discrepancies in the time duration are analyzed here.

Conclusion :

- ❖ In our study it was found that the number of days required to achieve muscle power Grade III was significantly lesser in the ulnar nerve transfer group.
- ❖ The number of days required to achieve muscle power Grade III was maximum in intercostal nerve transfer group.

The possible reasons for this are

1. Shorter neuromuscular junction to coaptation site distance
2. The sensory fascicle contamination is less in case of ulnar and median nerve transfers.

- ❖ The post-operative complications are more in intercostal nerve transfers because of the long incision and extensive tissue handling.

Patients should be highly motivated and should understand the procedure. They should be ready to do regular physiotherapy. They should realize that elbow reanimation is one step in the multi-staged brachial plexus repair.

To sum up, transfer of well vascularized nerves containing pure motor fascicles gives superior results.

BIBLIOGRAPHY:

1. Kozin SH. Congenital differences about the elbow. Hand Clin 2009;25(2):277–91.

2. Chomiak J, Dungl P. Reconstruction of elbow flexion in arthrogryposis multiplex congenita type I. Part I: surgical anatomy and vascular and nerve supply of the pectoralis major muscle as a basis for muscle transfer. J Child Orthop 2008;2(5):357–64.

3. Chuang DC, Ma HS, Wei FC. A new evaluation system to predict the sequelae of late obstetric brachial plexus palsy. Plast Reconstr Surg 1998;101(3):673–85.

4. Chuang DC, Hattori Y, Ma HS, et al. The reconstructive strategy for improving elbow function in late obstetric brachial plexus palsy. Plast Reconstr Surg 2002;109(1): 116–26; discussion 27–9.

5. Liao HT, Chuang DC, Ulusal AE, et al. Surgical strategies for brachial plexus polio-like paralysis. Plast Reconstr Surg 2007;120(2):482–93.

6. Birch R. Brachial plexus injury: the London experience with supraclavicular traction lesions. Neurosurg Clin N Am 2009;20(1):15–23, v.

7. Terzis JK, Kostopoulos VK. The surgical treatment of brachial plexus injuries in adults. Plast Reconstr Surg 2007;119(4): 73e–92e.

8. Flores AJ, Lavernia CJ, Owens PW. Anatomy and physiology of peripheral nerve injury and repair. Am J Orthop 2000; 29(3):167–73.

9. Sunderland S. Brachial plexus injuries. Clin Neurol Neurosurg 1993;95(Suppl.):S1–2.

10. Tsai YA, Chuang TY, Yen YS, et al. Electrophysiologic findings

and muscle strength grading in brachioplexopathies. Microsurgery 2002;22(1):11–15.

11. Jivan S, Kumar N, Wiberg M, et al. The influence of pre-surgical delay on functional outcome after reconstruction of brachial plexus injuries. J Plast Reconstr Aesthet Surg 2009;62(4):472–9.

12. Narakas AO. Lesions found when operating traction injuries of the brachial plexus. Clin Neurol Neurosurg 1993;95(Suppl.): S56–64.

13. Narakas AO. The treatment of brachial plexus injuries. Int Orthop 1985;9(1):29–36.

14. Kay SP. Obstetrical brachial palsy. Br J Plast Surg 1998;51(1): 43–50.

15. Clarke HM, Curtis CG. An approach to obstetrical brachial plexus injuries. Hand Clin 1995;11(4):563–80; discussion

80–1.

16. Uerpairojkit C, Leechavengvongs S, Witoonchart K, et al. Nerve transfer to serratus anterior muscle using the thoracodorsal nerve for winged scapula in C5 and C6 brachial plexus root avulsions. J Hand Surg (Am) 2009; 34(1):74–8.

17. Gousheh J. Surgical technique for the treatment of C5 and C6 root avulsion. Acta Neurochir Suppl 2007;100:13–14.

18. Leechavengvongs S, Witoonchart K, Uerpairojkit C, et al. Combined nerve transfers for C5 and C6 brachial plexus avulsion injury. J Hand Surg (Am) 2006;31(2):183–9.

19. Bertelli JA, Ghizoni MF. Reconstruction of C5 and C6 brachial plexus avulsion injury by multiple nerve transfers: spinal accessory to suprascapular, ulnar fascicles to biceps branch, and triceps long or lateral head branch to axillary

nerve. J Hand Surg (Am) 2004;29(1):131–9.

20. Seddon HJ. Nerve grafting and other unusual forms of nerve repair. Spec Rep Ser Med Res Counc (GB) 1954;282: 389–417.

21. Seddon HJ. The surgery of nerve injuries. Practitioner 1960; 184:181–7.

22. Seddon H. Advances in nerve repair. Triangle 1968;8(7): 252–9.

23. Oberlin C, Beal D, Leechavengvongs S, Salon A, Dauge MC, Sarcy JJ. Nerve transfer to biceps muscle using a part of ulnar study and report of four cases. J Hand Surg (Am) 1994;19(2):232–7.

24. Chuang DC, Yeh MC, Wei FC. Intercostal nerve transfer of the musculocutaneous nerve in avulsed brachial plexus injuries: evaluation of 66 patients. J Hand Surg (Am) 1992;17(5):822–8.

25. Chuang DC, Epstein MD, Yeh MC, et al. Functional restoration of elbow flexion in brachial plexus injuries: results in 167 patients

(excluding obstetric brachial plexus injury). J Hand Surg (Am) 1993;18(2):285–91.

26. Terzis JK, Kokkalis ZT. Elbow flexion after primary reconstruction in obstetric brachial plexus palsy. J Hand Surg Eur 2009;34:449–58.

27. Wellons JC, Tubbs RS, Pugh JA, et al. Medial pectoral nerve to musculocutaneous nerve neurotization for the treatment of persistent birth-related brachial plexus palsy: an 11-year institutional experience. J Neurosurg Pediatr 2009;3(5): 348–53.

28. Park TS. Medial pectoral nerve transfer. J Neurosurg Pediatr 2009;3(5):345–6; discussion 6–7.

29. Songcharoen P. Management of brachial plexus injury in adults. Scand J Surg 2008;97(4):317–23.

30. Monreal R. Restoration of elbow flexion by transfer of the phrenic nerve to musculocutaneous nerve after brachial plexus injuries. Hand (NY) 2007;2(4):206–11.

31. Liverneaux PA, Diaz LC, Beaulieu JY, et al. Preliminary results of double nerve transfer to restore elbow flexion in upper type brachial plexus palsies. Plast Reconstr Surg 2006;117(3): 915–19.

32. Moissonnier P, Cuvilliez V, Klein A, et al. Restoration of elbow flexion by performing contralateral lateral thoracic and thoracodorsal nerve transfers after experimental musculocutaneous nerve transection. J Neurosurg 2005;103(1):70–8.

33. Novak CB, Mackinnon SE, Tung TH. Patient outcome following a thoracodorsal to musculocutaneous nerve transfer for reconstruction of elbow flexion. Br J Plast Surg 2002;55(5):416–19.

34. Xu WD, Gu YD, Xu JG, et al. Full-length phrenic nerve transfer by means of video-assisted thoracic surgery in treating brachial plexus avulsion injury. Plast Reconstr Surg 2002;110(1):104–9; discussion 10–11.

35. Merrell GA, Barrie KA, Katz DL, et al. Results of nerve transfer techniques for restoration of shoulder and elbow function in the context of a meta-analysis of the English literature. J Hand Surg (Am) 2001;26(2):303–14.

36. Gu Y, Xu J, Chen L, et al. Long term outcome of contralateral C7 transfer: a report of 32 cases. Chin Med J (Engl) 2002; 115(6):866–8.

37. Gu YD. Contralateral C7 root transfer over the last 20 years in China. Chin Med J (Engl) 2007;120(13):1123–6.

38. Gu YD, Shen LY. Electrophysiological changes after severance of the C7 nerve root. J Hand Surg Br 1994;19(1):69–71.

39. Songcharoen P, Wongtrakul S, Mahaisavariya B, et al. Hemi-contralateral C7 transfer to median nerve in the treatment of root avulsion brachial plexus injury. J Hand Surg (Am) 2001;26(6):1058–64.

40. Songcharoen P, Wongtrakul S, Spinner RJ. Brachial plexus injuries in the adult. nerve transfers: the Siriraj Hospital experience. Hand Clin 2005;21(1):83–9.

41. Jivan S, Novikova LN, Wiberg M, et al. The effects of delayed nerve repair on neuronal survival and axonal regeneration after seventh cervical spinal nerve axotomy in adult rats. Exp Brain Res 2006;170(2):245–54.

42. Belzberg AJ, Dorsi MJ, Storm PB, et al. Surgical repair of brachial plexus injury: a multinational survey of experienced peripheral nerve surgeons. J Neurosurg 2004;101(3):365–76.

43. Kline DG. Timing for brachial plexus injury: a personal experience. Neurosurg Clin N Am 2009;20(1):24–6, v.

44. Kline DG. Timing for exploration of nerve lesions and evaluation of the neuroma-in-continuity. Clin Orthop Relat Res 1982;163:42–9.

45. Kline DG, Hackett ER. Reappraisal of timing for exploration of civilian peripheral nerve injuries. Surgery 1975;78(1): 54–65.

46. Schulze Berge. Ersatz der Beuger des Vorderarmes (Bizeps und Brachialis) durch den Pectoralis major. Deutsche med Wochenschr 1917;43:433.

47. Clark JPM. Reconstruction of biceps brachii by pectoral muscle transplantation. Br J Surg 1946;34:180.

48. Brooks DM, Seddon HJ. Pectoral transplantation for paralysis of the flexors of the elbow; a new technique. J Bone Joint Surg (Br) 1959;41(1):36–43.

ROFORMA

RESULTS OF BICEPS BRACHII NEUROTIZATION USING ULNAR MEDIAN AND INTERCOASTAL NERVES

Patient's Name : ……………………………………………………

Age / Sex : ……………………………………………………

IP No. : ……………………………………………………

Contact Address : ……………………………………………………

……………………………………………………

……………………………………………………

Contact Number : ……………………………………………………

Preoperative details :

1. Nature of the injury ; 2. Etiology ; 3. Roots involved ; 4. Sensory deficit (Yes / No) ; 5. Previous surgeries 6. Time of denervation

Co-Morbidity : ……………………………………………………

Risk factors : ……………………………………………………

Donor nerve assessment : ……………………………………………………

Procedure done : ……………………………………………………

Intraplexial/extra plexial…….

Intraoperative details :

Distance from coaptation site to neuromuscular junction…… nerve grafts (Y/N).

Post-operative period:

Follow up:

Number of days for achieving Grade III elbow flexion

MASTER CHART

S.NO	Name	Sex	Age	IP No	Etiology	Type of Injury	Nerve Transferred	Distance from NMJ to Coaptation Site	No. of days to get Gr.III Power
1	ravichandran	M	19	55734	RTA	Global Palsy	ICN	4.6	280
2	kathappan	M	23	33272	RTA	Global Palsy	ICN	6	244
3	nandhan	M	29	103791	RTA	Global Palsy	ICN	5.9	249
4	pandian	M	15	23182	Assault	Global Palsy	ICN	4.9	244
5	anbu	M	19	11688	RTA	Global Palsy	ICN	5.9	265
6	kumaran	M	24	39087	Fall	Global Palsy	ICN	5.4	287
7	narayanamoorthy	M	21	23832	RTA	Global Palsy	ICN	6.1	255
8	anjali	F	46	18763	Assault	Global Palsy	ICN	6.2	267
9	kuppusamy	M	17	54490	RTA	Global Palsy	ICN	5.7	244
10	kuberan	M	25	13952	RTA	Global Palsy	ICN	5.9	264
11	Kasi	M	31	46271	RTA	Global Palsy	ICN	5.8	280
12	martin	M	15	54310	RTA	Global Palsy	ICN	4.9	254
13	kathiresan	M	34	22572	Assault	Global Palsy	ICN	5.8	265
14	sunderasan	M	16	17943	RTA	Global Palsy	ICN	5.6	252
15	bhuvaneswari	F	24	23849	RTA	Global Palsy	ICN	6.6	269
16	rajan	M	21	23788	Fall	Global Palsy	ICN	5.8	259
17	pounraj	M	29	23613	RTA	Global Palsy	ICN	6.5	264
18	devan	M	15	20815	Assault	Global Palsy	ICN	4.9	269
19	rajendran	M	32	30793	RTA	Global Palsy	ICN	5.7	248
20	kumariah	M	19	439292	RTA	Global Palsy	ICN	6.1	268
21	kannan	M	17	34944	RTA	Global Palsy	ICN	5.5	261
22	gokul	M	20	26559	RTA	Global Palsy	ICN	6.3	255
23	navneeth	M	33	65048	RTA	Global Palsy	ICN	4.6	249
24	arunmoorthy	M	22	72245	Assault	Global Palsy	ICN	5.9	260
25	aravind	M	16	22613	RTA	Partial Palsy	Ulnar N	1.7	173
26	ponvannan	M	16	91349	RTA	Partial Palsy	Ulnar N	1.8	162
27	ganapathy	M	29	58636	Fall	Partial Palsy	Ulnar N	1.2	179
28	elangovan	M	23	913273	RTA	Partial Palsy	Ulnar N	1.7	165
29	gunasekaran	M	52	39652	RTA	Partial Palsy	Ulnar N	2.1	172
30	shanti	F	19	41326	RTA	Partial Palsy	Ulnar N	1.6	166
31	ravi	M	28	31359	Assault	Partial Palsy	Ulnar N	2.2	169
32	karthik	M	41	65216	RTA	Partial Palsy	Ulnar N	1.5	173
33	sudhakar	M	35	92082	RTA	Partial Palsy	Ulnar N	1.2	165
34	anton	M	24	34296	Assault	Partial Palsy	Ulnar N	1.7	165
35	suganthe	F	38	92212	RTA	Partial Palsy	Ulnar N	1.3	168
36	gautham	M	29	78343	Fall	Partial Palsy	Ulnar N	1.5	178
37	anand	M	20	74868	RTA	Partial Palsy	Ulnar N	1.5	175
38	charles	M	47	93783	RTA	Partial Palsy	Median N	2.1	193
39	hari	M	30	59137	Assault	Partial Palsy	Median N	1.4	205
40	senthil	M	16	29638	RTA	Partial Palsy	Median N	1.9	207
41	govind	M	34	62519	RTA	Partial Palsy	Median N	2.1	194
42	rajesh	M	16	66812	RTA	Partial Palsy	Median N	1.8	206
43	geetha	F	27	59624	Fall	Partial Palsy	Median N	1.7	198

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Imagine waking up to realize that your hand simply stops following your command. In a nut shell this is what happens in brachial plexus injuries.

Absence of functionality is one of the devastating effects of brachial plexus injuries. Apart from it brachial plexus injury also results in loss of sensation in the affected limb. The affected person also undergoes a period of depression. Many affected persons never return to their normal life.

Brachial plexus injury has plagued human species for a long

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Brachial plexus injury has plagued human species for a long time. It was only at the beginning of this century people started treating brachial plexus injuries. Only in the preceding thirty to forty years advances were made in treatment of brachial plexus injuries.

Treatment of brachial plexus injury is multi-staged. Separate operations are required for shoulder, elbow and finger re-